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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/714,305	11/14/2003	Jei-Wei Chang	HTIRC03-005	2109
7590 GEORGE O. SAILE 28 DAVIS AVENUE POUGHKEEPSIE, NY 12603			EXAMINER CHACKO DAVIS, DABORAH	
			ART UNIT 1795	PAPER NUMBER
			MAIL DATE 10/18/2007	DELIVERY MODE PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

## Office Action Summary

Application No.

10/714,305

Applicant(s)

CHANG ET AL.

Examiner

Daborah Chacko-Davis

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 02 August 2007.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-9 and 32-34 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-9, 32-34 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- ☐ Notice of Informal Patent Application
- ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Claim Rejections - 35 USC § 102*

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 32, 34, are rejected under 35 U.S.C. 102(b) as being anticipated by U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada).

Yamada, in col 3, lines 29-64, in col 4, lines 63-68, in col 5, lines 1-13, and figure 1(a) through figure 1(d), discloses a photoresist pattern suitable for liftoff, having sidewalls and an upper surface (see reference 15), performing an ion beam irradiation so as to cause hardening of the resist surface on the top portion (upper surface hardened) of the resist pattern that is resistant to chemical attack (i.e., the ion beam irradiation or sputter cleaning is too weak to etch the resist pattern surface), such that the bottom portion (shadowed region) of the resist pattern remains unhardened, exposing the resist pattern to oxidation using plasma ashing (for 5 minutes) resulting in the under cut of the photoresist pattern (unhardened bottom portion of the resist pattern eroded), wherein the top portion of the resist pattern (upper portion) overhangs the bottom shrunk portion (i.e., the bottom part of the resist pattern is thinned), removing the shrunk bottom portion of the photoresist resulting in a lift-off of the material that is deposited on the resist pattern. Yamada, in col 5, lines 10-12, discloses that the hardened layer (unetched overhang) overhangs the shrunk bottom resist by about 0.1μ

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(bottom 200nm shorter than the top width) on each side (claim 32). Yamada, in col 5, lines 1-16, discloses that the ion beam is impinged on the resist pattern for about 3 minutes, and the top hardened layer of the resist pattern extends to about 50nm (claim 34).

***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-2, 5-6, and 8, are rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein).

Yamada, in col 3, lines 29-64, in col 4, lines 63-68, in col 5, lines 1-13, and figure 1(a) through figure 1(d), discloses a photoresist pattern, and a liftoff method comprising forming a resist pattern (i.e., a photoresist layer is formed on the substrate or electrode layer, exposed and developed the photoresist layer to form a resist pattern) having sidewalls and an upper surface (see reference 15), performing an ion beam irradiation so as to cause hardening of the resist surface on the top portion (upper surface hardened) of the resist pattern that is resistant to chemical attack (i.e., the ion beam irradiation or sputter cleaning is too weak to etch the resist pattern surface), such that

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the bottom portion (shadowed region) of the resist pattern remains unhardened, exposing the resist pattern to oxidation using plasma ashing (for 5 minutes) resulting in the under cut of the photoresist pattern (unhardened bottom portion of the resist pattern eroded), wherein the top portion of the resist pattern (upper portion) overhangs the bottom shrunk portion (i.e., the bottom part of the resist pattern is thinned), forming a layer (depositing) of thin film over the resist pattern (and all exposed surfaces, i.e., all horizontal surfaces) at a thickness less than that of the bottom under cut portion (unhardened photoresist layer), removing the shrunk bottom portion of the photoresist resulting in a lift-off of the material that is deposited on the resist pattern (claim 1 ). Yamada, in col 4, lines 36-37, discloses that the resist is a positive resist (claim 2). Yamada, in col 5, lines 1-16, discloses that the ion beam is impinged on the resist pattern for about 3 minutes, and the top hardened layer of the resist pattern extends to about 50nm (claims 5-6). Yamada, in col 5, lines 10-12, discloses that the hardened layer (unetched overhang) overhangs the shrunk bottom resist by about  $0.1\mu$  (bottom 200nm shorter than the top width) on each side (claim 8). Yamada, in col 5, lines 60-63, discloses that the unhardened photoresist layer (resist pattern with the undercut portion) is removed by treating the resist with the developer.

The difference between the claims and Yamada is that Yamada does not disclose exposing the resist pattern to ozone.

Bloomstein, in col 11, lines 60-67, in col 12, lines 1-7, discloses performing an ozone exposure process after exposing the resist.

Therefore it would be obvious to a skilled artisan to modify Yamada by

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replacing the oxygen plasma ashing with an ozone oxidation step as suggested by Bloomstein because Bloomstein, in col 14, lines 1-7, discloses that the resist surface treatment can be performed by either ozone treatment or oxygen plasma treatment, and Bloomstein, in col 19, lines 30-40, discloses that treatment with ozone as claimed increases the hydrophilicity of the surface of the resist, and increases the surface energy of the polymers in order to promote adhesion.

5. Claim 3, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as applied to claims 1-2, 5-6, 8, 32, 34-35 above, and further in view of U. S. Patent no. 6,383,944 (Furihata et al., hereinafter referred to as Furihata).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose that the photoresist layer thickness is between about 0.1 and 0.4 microns (claim 3).

Furihata, in col 2, lines 28-36, discloses that the resist layer thickness in the lift-off resist pattern is about 0.5 $\mu$ .

Therefore it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein by employing the resist thickness suggested by Furihata because Furihata, in col 2, lines 40-49, discloses that if the thickness range is beyond the range suggested the lift-off resist pattern would be less smooth to lift off.

6. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as applied to claims 1-2, 5-6, 8, 32, 34-35 above, and further in view of U. S. Patent Application Publication No. 2004/0018742 (He et al., hereinafter referred to as He).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose that the ion beam has an energy between about 50 and 200 volts (claim 4).

He, in paragraph no. [0052], discloses that the resist pattern (image 110, see figure 4B and 4C) is exposed to an ion beam irradiation at about 100 volts.

Therefore, it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein to expose the photoresist pattern to an ion beam of the claimed energy because He in [0052], teaches that exposing the image (resist pattern, 110) to ions at the claimed energy results in a thicker etch-resistant layer (i.e., thicker hardened layer) at its tops surface due to enabling the ion radicals to penetrate deeper into the image layer (without etching the image layer, see figure 4B, 4C).

7. Claim 7, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as applied to claims 1-2, 5-6, 8, 32, 34-35, above, and further in view of U. S. Patent Application Publication No. 2002/0001957 (Kim et al., hereinafter referred to as Kim).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

Bloomstein, in col 12, lines 1-7, in col 15, lines 40-45, in col 24, lines 25-52, and in figure 6B, discloses using the ozone concentration of about 1-2 volume percent (i.e., 10 to 20 gm/m<sup>3</sup>), and correspondingly the claimed flow rate as recited for performing the ozone exposure for at least a minute.

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose that the photoresist pattern is exposed to the ozone atmosphere in an ozone chamber while being heated at a temperature of about 70-150°C.

Kim, in paragraph no. [0022], discloses that the temperature in the ozone asher (ozone chamber) is maintained at a low temperature of at least 130°C during the ozone ashing treatment of the photoresist pattern.

Therefore it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein by employing the method of using the claimed temperature range during the ozone treatment of the photoresist pattern as suggested by Kim because Kim, in [0022], discloses that maintaining the ozone asher at the claimed low temperature range enables the ashing of the photoresist pattern at a low etch rate such that the width of the photoresist pattern can be made fine without causing the pattern to fall down.

8. Claim 9, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent No. 6,833,234 (Bloomstein et al., hereinafter referred to as Bloomstein) as

applied to claims 1-2, 4-8, 32, 34-35 above, and further in view of U. S. Patent No. 5,512,334 (Leuschner et al., hereinafter referred to as Leuschner).

Yamada in view of Bloomstein is discussed in paragraph no. 6.

Bloomstein, in col 23, lines 38-65, in col 24, lines 25-45, discloses that the resist is developed at the claimed temperature range the PAB temperature is maintained, and developing time (see figure 10).

The difference between the claims and Yamada in view of Bloomstein is that Yamada in view of Bloomstein does not disclose using an NMP as the developer.

Leuschner, in col 2, lines 31-34, and in col 3, lines 20-25, discloses that the lift-off resist is heated and developed by means of N-methyl pyrrolidone (NMP).

Therefore, it would be obvious to a skilled artisan to modify Yamada in view of Bloomstein by employing the developer and developing process suggested by Leuschner because Leuschner, in col 2, lines 30-31, discloses that heating the resist enables the removal of the resist with the claimed developer, and Leuschner in col 3, lines 20-24, discloses the bottom portion of the resist together with the top hardened portion of the resist can be dissolved with a non-toxic organic solvent such as NMP.

9. Claim 33, is rejected under 35 U.S.C. 103(a) as being unpatentable over U. S. Patent No. 4,904,619 (Yamada et al., hereinafter referred to as Yamada) in view of U. S. Patent no. 6,383,944 (Furihata et al., hereinafter referred to as Furihata).

Yamada is discussed in paragraph no. 4.

The difference between the claims and Yamada is that Yamada does not

disclose that the photoresist layer thickness is between about 0.1 and 0.4 microns (claim 33).

Furihata, in col 2, lines 28-36, discloses that the resist layer thickness in the lift-off resist pattern is about 0.5 $\mu$ .

Therefore it would be obvious to a skilled artisan to modify Yamada by employing the resist thickness suggested by Furihata because Furihata, in col 2, lines 40-49, discloses that if the thickness range is beyond the range suggested the lift-off resist pattern would be less smooth to lift off.

### ***Response to Arguments***

10. Applicant's arguments filed August 2, 2007, have been fully considered but they are not persuasive. The 103 rejections made in the previous office action (paper no. 20070428) are maintained.

A) Applicants argue that Yamada does not teach exposing the photoresist layer to an ion beam such that the energy of the ion beam is too low to sputter the photoresist layer.

Yamada, in col 5, lines 1-12, discloses irradiating with a sputter ion beam at the claimed energy level to harden the surface of the photoresist. Yamada does not teach sputtering the photoresist layer. Additionally, Yamada teaches performing a sputter cleaning followed by a plasma ashing in an oxygen gas atmosphere in order to reduce the bottom width i.e., the sputter clean process is not strong enough to cause a

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considerable sputter etching. Yamada, in col 3, lines 44-51, and in col 5, lines 10, discloses,

ashing. When reforming and shrinking the sidewall of the resist pattern (15), the cross section of the resist pattern (15) should preferably be terraced to have a slight overhang. To form a terrace having an overhang, it is required to harden the resist film surface by sputter cleaning with high energy particles in advance. Without this process, it is difficult to form a lift-off mask of a desired shape. Namely, the conditions of oxygen sputter

layer (55). After this, the substrate (31) is unloaded from the vacuum chamber, and its resist surface is hardened by sputter etching using oxygen gas under the conditions of oxygen gas pressure of 0.8 Pa, radio frequency power of 20 W and treatment time of 3 minutes. In succession, plasma ashing is conducted for 5 minutes at oxygen gas pressure of 65 Pa and radio frequency power of 300 W. As a result, the shrunk width of the resist film is about 150 nm from the end of the junction pattern, leaving a terrace on the resist film as reduced by some 100 nm. After treatment, the resist pattern is

i.e., Yamada teaches hardening the photoresist and not etching the photoresist pattern.

The plasma ashing performed after the hardening process, results in a resist pattern wherein the surface of the resist pattern (i.e., the top portion) forms an overhang (or terrace) and the bottom portion of the resist pattern is shrunk by the claimed amount.

B) Applicants argue that Yamada does not teach an ion beam of the claimed voltage.

Yamada, in col 5, lines 1-3, discloses that the photoresist surface is subjected to a sputter ion beam exposure with an RF power of about 20W. However, He is depended upon to disclose the claimed ion beam energy of about 100volts. See paragraph no.6.

C) Applicants argument below,

In rebutting our argument, (presented as part of our response dated 02/15/2007)

that Yamada does not teach an ion beam voltage of about 200 volts (claimed range), examiner states that Yamada "is depended upon to disclose the claimed ion beam energy of about 100 volts. See paragraph no. " (sic). Since we cannot respond to this unless examiner provides us with the paragraph no. in question, we respectfully request that she do so in the form of another, non-final, rejection or that she abandon this part of her argument.

Response: See paragraph B) above. Paragraph B) above and the paragraph B) in paper no. 20070428, does not state that Yamada is depended upon to disclose the claimed voltage of about 200 volts. This argued limitation is part of claim 4. Claim 4, recites,

4. (original) The liftoff method recited in claim 1 wherein said ion beam has an energy between about 50 and 200 volts.

Claim 4 was clearly rejected in paragraph no. 8. of the previous office action (paper no. 20070428). Also, previous office action (paper no. 20070428), argument B) also clearly stated that "He is depended upon to disclose the claimed ion energy of about 100 volts".

D) Applicants argue that Bloomstein does not teach a change in dimension in the resist exposed to ozone.

Bloomstein is not depended upon to show a change in dimension in the photoresist. Bloomstein is depended upon to show the interchangeability of photoresist exposure to either an ozone treatment or an oxygen plasma treatment. Additionally, as discussed in paragraph A), Yamada teaches that the resist pattern width of the bottom

portion is considerably shrunk after the plasma ashing process in the oxygen atmosphere.

### ***Conclusion***

11. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Daborah Chacko-Davis whose telephone number is (571) 272-1380. The examiner can normally be reached on M-F 9:30 - 6:00. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark F Huff can be reached on (571) 272-1385. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published

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applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

dcd

October 15, 2007.



**JOHN A. MCPHERSON**  
**PRIMARY EXAMINER**